

The SAE Journal's NEW Index

The NEW Index of the 1964 SAE Journal printed on these green pages is a welcome paradox. Although the size of the Index is increased, and it will probably take you longer to read a specific entry, it should *cut* the time it takes you to find information. The new system is designed to make each moment you spend looking for information more productive. The final objective is that you only go back and read articles that actually bear on your problems.

Here is the way to use the new Index:

- Look up the subject heading of interest.
- Select all the titles under each subject heading that are of specific interest. Note the 6-digit number to the right of each title.
- In the Abstract Section, which follows the Index, look up the selected Abstracts by means of the 6-digit numbers. (Abstracts are in numerical order.)
- Look up all the articles that the comprehensive Abstracts show should have information of use to you. (Each article can be located by means of the code number to the left of the 6-digit number in the Index. For example, JL64-8-60 means: SAE Journal, 1964, August, article starts on p. 60.)

The new Index thus gives you two stages of prescreening before you start pulling old issues. In a way, it's like making changes in the design stage of a product, rather than during production.

At *each* step of the way the new Index is tailored to do a higher quality job. First, the subject headings used are those agreed upon by 14

technical societies in an Engineers Joint Council project to simplify interdisciplinary terminology and indexing. As part of this approach, each article is indexed under three times as many entries as in previous indexes, thus giving you a better chance of finding the articles you need.

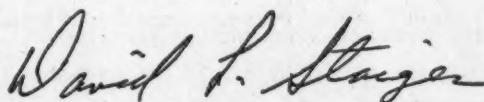
In addition, an expanded title is used for each article under the subject headings. This helps in your first stage of prescreening, since the expanded title is really a very short Abstract. If you are looking only for background information in a new field, chances are you won't have to go beyond this point to find the articles you want.

Next, the inclusion of Abstracts for each technical article printed in SAE Journal during 1964 is a new depth service that allows careful selection without ever leaving the "green pages."

Finally, an Author Index is included, so you can find what articles have been contributed by a particular author.

Like any improved service, the cost is always an important factor. By the format of the Index, you can see that computers have come to our aid. Their use has not only made this new service practical, but has eliminated the expense of weeding out errors that are introduced during a typesetting operation.

Your Publication Committee presents this new Index as one of a series of services to make SAE information more useful through modern data retrieval methods, and hopes you will find it of value in your work.



MANAGER AND EDITOR, SAE PUBLICATION DIVISION

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SAE JOURNAL - JANUARY THROUGH DECEMBER, 1964 - VOL. 72

The following very general terms have not been used as subject headings: Accidents, Aircraft, Automobiles, Design, Engines, Fuels, Maintenance, Motor Vehicles, and Transportation. Look under more specific headings such as Diesel Fuels, Gasoline Engines, and Truck Maintenance.

Some very general papers have been listed under broad headings such as Materials, Engine Design, or Automobile History. However, these headings do not carry papers on specific subjects.

Engineers Joint Council Thesaurus preferred terms are used where there is alternate nomenclature in the industry. For instance, Nodular Iron is used, rather than Ductile Iron or Spheroidal Iron.

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640001 High-Lift Plane Design Lifts Local Airlines' Prospects.

F. G. Wagner, Ryan Aeronautical Co. The knack of turning progress to profit seems always to evade domestic local airlines, but a low-cost transport using a high-lift system may yet save the day. A system for achieving this, now under experimental development, uses an advanced form of boundary layer control. This system offsets the stalling of lifting and control surfaces caused by boundary layer effects by removing some of the boundary layer and energizing other portions of it. BLC systems commonly use only one or the other of these methods. Those that remove the boundary layer are called suction systems, while those that energize it are called blowing systems. In the combined system the same air is used twice. The same jet pump that sucks air from one section of the wing blows the same air over another section of the wing.

640002 Split System Hydraulic Brakes Fail Safe.

R. L. Atkin, Kelsey-Hayes Co.; P. B. Shutt, Bendix Products Lakeshore Division, and D. J. Gardner and C. N. French, Bendix Products Automotive Division, Bendix Corp. Split hydraulic brake systems employ a tandem master cylinder to separate the conventional hydraulic circuitry into two sections, with each section being made up of brakes by their axle combination. The tandem cylinder has two independent fluid reservoirs and bores, and by this means it continues to operate either section alone in the event that a failure occurs in the other. The make-up of the system, because there is no splitting between brakes on the same axle, facilitates vehicle direc-

tional stability and control when either section is operated in the absence of the other.

640003 Aerospace Age Presents New Challenges for Manufacturing.

G. I. Beckwith, Aerospace Division, Boeing Co. Supersonic aircraft, boosters, and space vehicles will present manufacturing with a new, wide range of requirements to meet before long. For example, manufacturing will be called upon to use precipitation-hardening stainless steels and high-strength titanium alloys such as 8Al-1Mo-1V in the manufacture of future aircraft.

640004 Load-Torque Analysis Is Basis For Legal Stop Ability Design.

G. P. Mathews, Brake Division, Rockwell-Standard Corp. How to provide a vehicle with legal stopping ability and adequate braking control is illustrated by considering a specific hypothetical vehicle . . . because the major factor affecting the design of a practical brake system is the nature of the vehicle itself. For purposes of analysis, we assume a 4-wheel truck rated at 25,000 lb gvw. Payload is assumed to have a constant density of 125 lb per cu ft, always centered on the load platform and uniformly distributed to produce minimum change in height of the load center of gravity. Retarding force ranges from 0 to 80% of the vehicle weight.

640005 Beat Buckling in Truck Frames.

S. J. Shomberger, and E. A. Wingerson, Ford Motor Co. In the design of truck frame siderails, utilizing high strength steels, one of the chief concerns is to adjust the di-

mensions of the siderail so that failure by buckling of the compression flange will not occur at a stress appreciably lower than the yield strength of the material.

It has been shown both in the laboratory and in actual field tests that the greatest number of failures occur in the top or compression flange of the frame side member. This is not surprising since the use of the new high yield strength steels has led to truck frame members thinly proportioned and highly stressed—an ideal situation for buckling wherever compression occurs.

640006 Flameout Sensor Relights Engine Automatically.

H. C. Welch, Scintilla Division, Bendix Corp. A new flameout sensor relights a gas turbine engine automatically when combustion is interrupted. Recently it performed this function on a teststand in 1.4 sec. Flight test results show reliable monitoring of flameouts and good relight results.

Heart of the device is a pressure-sensitive switch that turns on the ignition when compressor discharge (CDP) drops below a preselected value. When the engine has been relit, CDP rises to its normal value and the switch turns the ignition off. The short duration of ignition operation insures maximum ignition and spark-plug life while maintaining safe operating conditions as though ignition was continuous.

640007 Hydraulic System Provides Full-Time, 2-Speed Manueverability Power Steering for 2-Wheel Tractors.

R. D. Johnson, Allis-Chalmers Mfg. Co. Allis-Chalmers motor scrapers are now avail-

able with a simplified hydraulic steering system based on control of the articulation angle between tractor and scraper. A choice of slow speed steering for travel and high speed steering for operation in close quarters for loading and dumping is a standard feature of the system. Turn angle maximum is 90 deg in either direction with the vehicle either moving or standing still. Manual control is by steering wheel from the operator's compartment.

640008 Solid Propellants Power Emergency Hydraulic Systems.

M. L. Caplan, Aerospace Division, Vickers, Inc. An attractive new way to produce emergency hydraulic power on manned aircraft is through use of solid propellants. Used, say, to actuate the landing gear on a large aircraft, there would be several advantages to be gained. The completely self-contained power supply could be located right at the point where the power is needed. Complete redundancy, including lines, could be achieved this way, while the weight of the hydraulic lines to the usually remote source of hydraulic power would be eliminated.

640009 Navy Steered to Cleaner Plane Hydraulic Systems.

N. F. Robinson, Aircraft Division, Douglas Aircraft Co., Inc. More realistic filter maintenance practice, better filtering media and filter design, and extra-fine filtration on ground support equipment should help the Navy clean up its aircraft hydraulic systems. This advice comes after a contamination study revealed a less than acceptable dirt level on many of the Navy's up-status planes.

Of the aircraft hydraulic systems scrutinized—all on flight line planes—close to 25% exceeded the class-5 contamination level defined by the tentative SAE, ASTM, and AIA standard for hydraulic fluids.

640010 Bringing the Field Into the Test Lab.

F. Blair, Jr., Allison

Division, GMC. Testing the endurance of transmissions and torque converters in the lab usually does not take into account dynamic or transient conditions encountered in the field. Allison Division has devised a test method in which field conditions are recorded on tape and then used in lab durability tests. It is successfully correcting product weaknesses, increasing reliability, lowering warranty costs, and providing new knowledge which may influence future transmission designs.

640011 VC-Ratio Engine.

W. A. Wallace, Continental Aviation and Engineering Corp.; and F. B. Lux, Army Tank Automotive Center. A new automatic hydraulically actuated piston provides a practical way to the variable-compression-ratio engine.

When applied to compression-ignition engines, an increase in output of 50% (compared to an open-chamber engine of fixed ratio) has been achieved without a corresponding increase in maximum combustion pressure. By providing a high compression ratio for starting and light-load conditions, the engine has demonstrated substantial improvements in cold-starting ability, as well as improved potential for multifuel operation.

640012 Pneumatic Power System Proposed for Flight Vehicles.

R. W. Casebolt, General Dynamics/Convair. A pneumatic power-transmission system is being studied for application to an air-breathing high-speed, low-altitude missile powered by a nuclear ramjet engine. It consists of a high-pressure, closed-loop compressor-powered pneumatic system operating an aerodynamic surface control valve and actuator.

640013 How Madison Bus Uses Dynamometer For Fleet Maintenance Inspection.

F. J. Wessel, Madison Bus Co. The Maxwell Electric Dynamometer is instrumental in

helping Madison Bus set better bus maintenance guidelines which result in fewer on-the-road breakdowns and lower part and labor costs. The dynamometer makes it possible to road test the bus at road speed while a test mechanic stands beside the vehicle and watches and listens for improper operation as the bus is tested.

640014 Graph Estimates Physical Properties of Lubricating Oil Blends.

L. W. Okon, McCollister Grease & Oil Corp. The physical characteristics of ternary blends of lubricating oil base stocks can be estimated graphically by a technique utilizing triangular coordinate paper.

640015 Car Tests Indicate Comfort-Acceleration Tie.

R. Fine, University of Wisconsin. Correlation between vertical acceleration and passenger comfort provides a positive step towards objective ride analysis.

To determine the relationship between acceleration and comfort, a test was devised to compare the characteristics of different vehicles. Each car was run over a level parking lot surface interrupted by a 1×2 in. board and 2×4 in. board placed 30 ft apart.

640016 Friction Heat—Factor In Liquid H₂ Line Design.

K. D. Folkerts and E. H. Hoag, AETRON. Enthalpy gain that accompanies pressure drop is an often overlooked factor in the design of pipes to carry liquid hydrogen for rocket engine test facilities. Many times, in an effort to cut down on the energy gained from heat leak, line size is reduced. But the resulting increase in pressure drop, with its corresponding energy rise due to fluid friction, can more than offset any gains made by heat leak reduction.

640031 Vehicle Directional Control Behavior Described in More Precise Terms.

Leading vehicle and tire engineers are close to agree-

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ment on terminology for vehicle directional control and tire characteristics, as a result of a recent SAE-sponsored seminar. Motivated by the pressing need for definitions permitting quantitative measurements instead of subjective evaluations, they approached agreement rapidly by using a previously developed General Motors suggested terminology as a start for discussion.

Elimination of inconsistencies and substitution of more precise and logical terms, the representative group envisioned, could bring many important advantages.

640032 Automobile Design Trends in Europe. M. Platt, Engineering Consultant. European car manufacturers, with record sales behind them for 1963, are almost without exception, continuing to expand their manufacturing facilities. The resulting intense competition for the automotive markets of the world has meant that all companies are continuing to give great attention to engineering and styling . . . with special emphasis on controlling costs, so that resulting improvements can be made without significant price increases. This situation is described in this article which presents a birdseye view of engineering and styling trends, and then describes in detail some of the interesting features of the newer cars being offered by makers both in England and on Continental Europe.

640033 What Should Be Done About Fuels and Lubricants for Construction Equipment? G. K. Brower, Construction Equipment Division, International Harvester Co. Standardization and simplifications of fuels and lubricant recommendations for construction equipment have

helped engineers greatly to design improved economy and reliability into their vehicles. . . . Most effective has been the cooperation effort of vehicle and petroleum engineers within the framework of SAE, Coordinating Research Council, American Society for Testing and Materials, and American Society of Lubrication Engineers. But the future will require continuing study. Even now, the author says, numerous changes in present practices are needed to improve the already excellent relationships between fuels, lubricants, and equipment. This article details the author's ideas about what ought to be done—now. Presented also is a summary of comments from several leading petroleum engineers on the author's recommendations.

640034 New Test Evaluates Quality of Anodized Aluminum. E. T. Englehart and G. Sowinski, Jr., Research Laboratories, ALCOA. A test for determining the quality of coating thickness and seal of anodized aluminum, especially useful for evaluating automotive trim, has been developed by Alcoa. It can be performed quickly, is nondestructive, adaptable to various trim configurations, and economical of equipment. This quality control test is based on the measurement of the impedance of the anodic coating. The magnitude of the impedance is a function of the insulating properties of the coating and the protective qualities are better as the impedance increases.

640035 Tandem Engines Make Private Flying Simpler. W. D. Thompson, Cessna Aircraft Co. The centerline-thrust (CLT) concept, aimed at making business and pleasure flying simpler and safer, will

probably hearten nonprofessional pilots who fly relatively low power twin-engine aircraft out of short fields. Instead of the conventional engine arrangement, the CLT concept places one engine behind the other. This is done to minimize the problems that arise when an engine fails during take-off.

640036 Electron Beam Produces Crack-Free Refractory Welds. S. M. Robelotto, Hughes Research Laboratories. Electron-beam welding is being used to join the porous tungsten emitter to the nonporous tungsten support of a contact ion engine. Previously, brazing was used to join these small pieces, but it was feared that, with extended operation, the brazing alloy would migrate into the porous tungsten, resulting in degradation of both the joint and the porous tungsten.

This process has also been successfully used to weld other refractory metal combinations; porous tungsten to tantalum; porous tungsten, tantalum, rhenium, and molybdenum to molybdenum; and also nonporous tungsten to molybdenum.

640037 Sandwich Structure Brazed by New Technique. P. W. Warren, Norair Division, Northrop Corp. A new technique for brazing sandwich structures gives higher strengths and elongation to the material than are obtainable with the induction furnace or by means of resistance heating. The complete cycle takes only about 1¾ hr, as compared with the 16–30 hr required with the older methods. In addition, it is applicable to refractory metals that have to be brazed at 2400–3000 F. Brazing at these temperatures is possible, of course, within a vacuum furnace, but such furnaces accommodate work no larger than 12 × 12 in. at the present time.

640038 Bifuel Operation Improves Diesel Acceleration. B. S. Murthy, Birla Institute of Technology.

Bifuel operation increased the acceleration of a diesel-powered truck more than turbocharging in road tests conducted at the University of Wisconsin. But part-load fuel consumption was higher than for turbocharged or naturally aspirated operation. Drawbar pull also increased, but not as much as with turbocharging. Bifuel operation was achieved by feeding commercial gasoline into the intake manifold through a side-draft carburetor.

640039 Blending Automatic Transmission Fluids For Proper Friction Properties. T. D. Newingham, Sun Oil Co. The additives in an automatic transmission fluid greatly affect the fluid's frictional characteristics. In fact, by properly selecting and blending the additives, it is possible to design a fluid with almost any desired frictional properties.

640040 56 Materials Produce Laser Action. Materials research has lead to a host of materials in addition to the ruby which will produce laser action, including other hard crystals, gases and gaseous mixtures, plastics, glasses, semi-conductors, and liquids.

Many of these materials may be operated in pulsed or continuous (cw) modes but some may be only pulsed. Others are pulsed at high repetition rates (quasi-cw).

640041 Hard Starting Traced to Poor Maintenance. R. C. Teasel and J. F. Hoffman, Champion Spark Plug Co. Motorists recognize the need for spring and fall tune-ups and some intend to have them performed, yet very few get around to it. Even when they suffer the annoyance of hard starting, few seek the service station for aid.

These facts were obtained by querying 13,954 motorists and the findings were reflected in the mechanical condition of their cars. One-

third of the vehicles were found to have ignition systems with low output and 60% of them needed spark-plug service or replacement. It is no wonder, perhaps, that one-fourth of the motorists reported hard starting.

640042 Control Adds Strength, Ductility to Aluminum Castings. D. N. Williams, Battelle Memorial Institute. Premium-quality aluminum castings featuring high levels of strength and elongation are being produced by controlling and eliminating voids and inclusions.

It is these voids and second-phase inclusions that cause cast alloys to have less strength and ductility than wrought alloys. Both defects occur in rather massive form in castings, due to the large grain size promoted by relatively slow rate of solidification. The voids can be traced either to the precipitation of hydrogen during solidification or to the volume shrinkage occurring on solidification.

640043 An Airline Looks at Aircraft Lighting Problems. R. Schwab, D. A. Murphy and R. E. McCann, United Airlines, Inc. Lighting problems continue to trouble the airlines. Three areas where improvements could be made are: instrument panels, exterior lighting components, and fluorescent light ballasts.

640044 Apollo Can Maintain Men on the Moon. G. L. Mitcham, Boeing Co. Not merely a fleeting visit to, but a protracted exploration of, the moon can be accomplished by the vehicles of the Apollo system. Supplies could be landed by a modified version of the Lunar Excursion Module (LEM), but for economy in the number of vehicles expended it would be more attractive to develop a Lunar Logistics Vehicle (LLV). The LLV would use cryogenic engines similar to those of the upper stage of the present Saturn I.

640045 Novel Mobility Research Methods Used in Army Vehicle Design. I. R. Ehrlich, Davidson Laboratory, Stevens Institute of Technology. Two methods, not previously used in mobility research, were employed recently during the design of a highway train of U.S. Army vehicles. These vehicles can be operated separately - when desired - or coupled together and operated as a vehicle train. Such a train configuration differs radically from the usual locomotive-type arrangement with all power emanating from one vehicle, and the others helpless, if detached.

640046 New Starter System Eliminates Panting When Cranking 2-Stroke Lawnmower Engines. G. J. Shaw, Lawn-Boy Division, Outboard Marine Corp. A new starting system for 2-stroke lawnmower engines has been developed that uses a primer instead of a choke, a modified ignition system, and a cord operated, rewind starter with horizontal axis, to achieve a 60% reduction in maximum cord pull.

640047 Centaur Program is LH₂ Pioneer. J. J. Gilbeau and D. G. Huber, General Dynamics/Astronautics. Liquid hydrogen transfer systems for the Centaur program have been operated successfully for four years. These systems were the first designed to handle large quantities of LH₂ in the field. Success was achieved through early solution of these problems: personnel training, vacuum manifolding fabrication, liquid air runoff and venting, and introduction of condensable gases.

640048 C. I. Test Engine Achieves 450 psi and 2 hp/cu in. With High Supercharging. I. O. Kamm, Davidson Laboratory, Stevens

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Institute of Technology; and M. R. Dragon, U.S. Army Tank Automotive Center. High power concentration – and therefore light weight and minimum installed volume – can be achieved with a highly supercharged compression-ignition engine, according to unfinished experimental work aimed at determining the effects and eventual limits of this technique. Most significant accomplishments to date are attainment of 450 psi imep and 2 hp per cu in. of displacement. Features of the aircooled, loop-scavenged, 2-stroke, single-cylinder test engine which make this power concentration possible include heat protection against high specific heat release and positive combustion control for reasonable peak pressures.

640049 Building Design Meets Vehicle, Mechanic Needs. W. F. Eaton, Mason and Dixon Lines, Inc. One design of a complete maintenance facility for a long haul common carrier features strictly functional planning. The design criteria establishes that the space be broken down according to the activities to be performed in each area. It provides for an abundance of light, ventilation, space, and all equipment and facilities required to efficiently perform the desired maintenance operations. The needs and convenience of the mechanics, and an overall consideration for future expansion is reflected in the planning.

640119 Make Statistics an Engineering Tool. The growing use of computers and buildup of packaged computer programs are giving engineers another tool for everyday use . . . statistical analysis. This is a timely tool since the emphasis on product reliability in recent years is

demanding engineering answers that can best be handled by statistical techniques.

The problem for the engineer using this tool is twofold. First, he must learn a new language that talks of regression, mean, deviation, and density functions, just as he learned of stress and strain, or integration . . . and second, he must catalog the various statistical solutions that can help solve his problems. After this, the computer becomes the way that large masses of data can be handled, either for condensation or for carrying out long statistical calculations.

640120 Faster Technical Advance Means Economic, Social Health. Henry Ford II, Ford Motor Co. If we have not had enough jobs in our economy during the past six years, the reason is not that we have had too much technological progress, but too little.

What we need even more than the refinement of old ideas is the ability to develop new ideas and put them to work. Development of new technology is a complex process involving translation of scientific discovery into practical applications – practical in an economic as well as in an engineering sense. This requires blending of qualities that are natural enemies: visions and dreams on the one hand, and hard common sense on the other. The challenge to industry: to create an environment for engineering and research that is free enough to encourage dreams and disciplined enough to lead to practical results.

640121 Laser Goes Miniature. D. A. Buddenhagen, Hughes Aircraft Co. Development of the laser has provided industry with a new and powerful tool for micromachining and microwelding materials. Basic

to both operations is the fact that a laser beam may be focused to a small spot of light or recollimated with simple, and in most cases, inexpensive lenses to produce power densities as high as 10^{15} w per cm^2 .

640122 Exotic Materials Need Exotic Metal – Removal. R. L. Rod, Acoustica Associates, Inc.; J. W. Meier, Hamilton Standard Division, United Aircraft Corp.; R. D. Engquist, Hughes Aircraft Co.; J. Sheaffer, Cincinnati Milling Machine Co.; and T. Rotundo, Allied Pacific Mfg. Co. Exotic new materials, together with the intricate shapes and delicate parts often found in advanced designs, demand equally exotic metal removal techniques. Standard machining methods, fine where large volumes of metal must be removed, have to be augmented by less conventional operations for many modern fabrication problems.

640123 Improved Techniques Handle Clean-Room Problems. Growth of clean-room acreage throughout the aerospace industry is demanding and getting improved techniques to control clean-room airborne contaminants as well as process-induced contaminants. Laminar air-flow, better process-induced contamination control, artificially created production environments are some of the areas of progress.

640124 Truck Operating Conditions Are Brake Balance Headache. G. P. Mathews, Brake Division, Rockwell-Standard Corp. The ever-present problem of maintaining brake balance on commercial road vehicles will vary to the same degree as the actual operating conditions vary from the hypothetical conditions which formed the basis of selection for the original brake system.

640125 A New Way to Select Vehicle Design Parameters. H. Moss, Grumman Aircraft Engineering Corp. A new procedure for getting vehicle

engine data to use in preliminary design studies provides parametric trending data for families of vehicles subject to various design requirements. The requirements are dictated by the application and, in general, are stated as performance and/or load-carrying capabilities for a particular mission or set of missions.

640126 "Dyna-Star" Design Shrinks Piston-Engine Size. W. G. Lundquist, Thiokol Chemical Corp. The "Dyna-Star" powerplant concept, suitable for use in either diesel- or spark-ignition engines, may prove to be a major advance in piston-engine technology. Still under development, it promises to give up to 2 hp per lb of engine weight and offer size, weight, and cost savings over comparably rated regenerative gas turbines—at least up to the 1000-bhp range.

The concept employs a 2-stroke engine designed to give uniflow scavenging and charging with unsymmetrical port timing. This is achieved not by unconventional mechanical contrivances, but by the salient feature of the engine—the U-type cylinder.

640127 Gas, Magnetic, and MHD Bearings Filling New Needs. J. W. Beams, University of Virginia; B. Sternlicht, Mechanical Technology, Inc.; and W. F. Hughes, Carnegie Institute of Technology. The gas bearing has become a hard-working component in turbomachinery and instruments. The magneto-hydrodynamic bearing, employing magnetized liquid metals, offers promise of practicality in such applications as controllable torque bearings and clutches. Magnetic bearings suspend a rotor in air or vacuum, and have successfully supported one spinning at 1,000,000 rpm!

640128 Wanted: One Design for Four Turbines. J. E. Montgomery, U.S. Army Engineer Research and Development Laboratories; H. R. Schelp and D. G. Furst, AiResearch Mfg. Co.

of Arizona. Four turbine engines—each of which must utilize the same basic design, with only minimum re-sizing of aerodynamic components, change of speed, or other simple alterations—are now under development by AiResearch for the U. S. Army Engineer R&D Laboratories. Two of these engines are to be of 300 hp, with one a simple cycle and one regenerative. Two more are to be rated at 200 hp, again one simple cycle and one regenerative.

640129 New Positive Steering System. D. R. Buerschinger and J. H. Hyler, LeTourneau-Westinghouse Co. A new concept in steering control of articulated heavy-duty ground vehicles, based on positive adjustment of the angle at the kingpin between the prime mover and the trailer, is a feature of the latest LeTourneau-Westinghouse Tournapull-scraper combination.

640130 Negative Camber Produces Positive Results. A. F. Weber, Firestone Tire and Rubber Co.; W. S. Coleman, White Motor Co.; K. Bretz, Denver-Chicago Trucking Co. Inc.; K. M. Koch, Rockwell-Standard Corp.; and W. F. Eaton, Mason and Dixon Lines, Inc. Recent tests by tire and axle manufacturers, and by trucking companies, indicate that excessive wear of tires mounted on the right front wheel may be corrected by a negative adjustment of the camber angle on that wheel. A quick-look summary of test results shows improved tire mileage when the right front wheel camber is set to $-1/2$ deg, with the left wheel set to $+1/2$ deg for balance.

640131 Pert Case Histories Prove Versatility. E. J. Hughes, Transmission & Chassis Division, Ford Motor Co.; S. F. Watanabe, R. D. Daily and E. N. Petrick, Kelsey-Hayes Co. PERT (Program Evaluation and Review Technique) is helping the automotive industry to plan

and control successfully such diversified applications as: the development of a complete program for a new transmission plant, including purchasing, plant layout facility tryouts, and control of the production line when operative; a project for the design, procurement, and test of a new disc brake; and a process research task for the development of a welding process control.

640280 Engineer Can Be Key to Industry Profits. M. J. Kittler, Holley Carburetor Co. Engineering is expanding at an ever-increasing rate. The engineer continually must broaden his knowledge to solve effectively the problems before him. Everything he is doing today, he is going to have to do better and cheaper tomorrow. The progress and prosperity of the world will depend, to an ever-increasing degree, on his contributions. And the vast impact of transportation on world affairs, marks the automotive engineer's contribution as of special importance.

640281 Computers Analyze Vehicle Frames. C. W. Schwabender, A. O. Smith Corp. Computers are being used to predict the rigidity of newly designed vehicle frames before a prototype is actually manufactured. This technique has resulted in frames of improved rigidity in less time and at lower cost.

640282 What Engine Will Power the Car of Tomorrow? E. S. Starkman, University of California. The conventional spark-ignition engine appears to be reaching an impasse in its development. Increases in economy and performance are becoming more and more difficult and costly to attain. And the most direct way to improvement—to raise the compression ratio—is becoming limited, so other configurations, such as the stratified-charge engine, the gas turbine, the Wankel rotating combustion engine, the free-piston engine,

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and direct energy conversion devices are beginning to look worthy of serious consideration.

640283 R-502 - Newest Refrigerant for Transport Cooling. E. E. Melby, Thermo King Corp. R-502, which promises to be a useful member of the fluorocarbon family of refrigerants, is an azeotropic mixture of R-22 (48.8%) and R-115 (51.2%). Its potential application is as a replacement for R-22 or R-12. It has a compressor discharge temperature equal to or lower than that of R-12 and 30-40 deg lower than that of R-22. The benefits from a lower discharge temperature will be a reduction in oil deterioration and in elastomer hardening in O-rings, hoses, and gaskets, and an end to the opening of soft solder joints.

640284 Three Ways to Put the "V" in VTOL. W. R. Morgan and H. C. True, General Electric Co.; H. B. Starkey, Ryan Aeronautical Co.; J. McReynolds, Lockheed-Georgia Co.; and G. Gilder and H. F. Carter, Ling-Temco-Vought, Inc. VTOL capability is designed into the XV-4A, XV-5A, and XC-142A aircraft in three entirely different ways. The XV-4A obtains vertical thrust by diverting and augmenting the exhaust from its two turbojet engines. The XV-5A is based on a gas coupled lift-fan system. The XC-142A is built around a tilt wing on which four turbine-engine-driven propellers are mounted.

640285 Tilt-Wing Aircraft in the Works. H. F. Carter, LTV Vought Aeronautics Division, Ling-Temco-Vought, Inc. The XC-142A tilt-wing aircraft is now under development for the military and should be ready to fly by mid-1965. Designed to operate from unprepared areas under all

weather conditions, the plane's main function will be to transport and air drop combat troops, support equipment, and supplies.

On a typical VTOL mission it will take off vertically, cruise 200 miles at not less than 250 knots, hover out of ground effect for 10 min (hover ceiling out of ground effect is 600 ft under standard day conditions), then it will land. The design ensures a controlled vertical landing with a safe rate of descent, even with one engine out. STOL performance with a 10,000-lb payload is to clear a 50-ft obstacle at a distance no greater than 400 ft.

640286 Redesigned Tempest Uses Separate Frame. J. H. Lagergren, Pontiac Motor Division, GMC. The newly introduced 1964 Pontiac Tempest (Fig. 1) is radically redesigned in respect to body and frame, transmission, engine, and suspension. Separate body and frame construction permits better isolation of the body from drivetrain and running gear components for lowered noise and vibration levels. The spring-over-axle rear suspension provides improved vehicle handling through understeer for lateral stability. Two new optional automatic transmissions, to meet various engine option requirements, offer faster, quieter operation. The 6-cyl standard engine, operating on regular-grade gasoline, develops 140 bhp at 2000 rpm, and is available with either 3- or 4-speed synchromesh transmission. Four optional V-8 engines are rated at 250, 280, 325, and 348 bhp to suit varying driver requirements.

The elimination of the transaxle and its torque tube makes it possible to integrate the manufacture of the Tempest with other GM cars that share the basic body structure in the

Buick, Oldsmobile, and Pontiac assembly plants.

640287 Modern Diffusion Bonding Meets Space-Age Needs. A. G. Metcalfe, Solar Aircraft Co. Diffusion bonding is a method of low-temperature bonding that is particularly applicable to: 1. Dissimilar metals; and 2. Metals that can be damaged or embrittled by high temperatures.

The process involves the use of: 1. Cleanliness and pressure to deform asperities and bring the surfaces into intimate contact. 2. Heat, for sufficient time, to allow a bond to grow across the contact by diffusion. Usually, the pressure and heat are applied at the same time.

640288 V/STOL Landings Smoothed by Letting Air Out of Tires. J. A. Hoess, Mechanical Energy Systems, and J. E. Voorhees, Battelle Memorial Institute; V. C. Frisby, Fairchild Stratos Corp. A high-flotation landing gear for improved operations from unprepared airfields has been developed by the Army. The new gear, which is intended for VTOL and STOL aircraft, has two basic features:

1. Low-pressure tires capable of supporting an aircraft on low-shear-strength soil and of rolling over obstructions without transmitting large forces to the aircraft.

2. A system that releases air from the tires at touchdown in order to dissipate the kinetic energy of the aircraft due to its vertical velocity.

640289 Ductile Iron Research Builds a Better Trap for Elusive Magnesium. P. K. Trojan, Dearborn Center, and R. A. Flinn, University of Michigan. Ductile iron production is increasing rapidly, but the methods of introducing magnesium into the cast-iron melt are inefficient. Undesirable dross and large amounts of carrier elements in the treated metal complicate the production problem. The high volatility of magnesium

causes difficulties in mixing optimum amounts into the molten iron. Solubility in iron is low and makes necessary the use of carriers, such as silicon, in undesirable amounts.

Laboratory research and experimentation are contributing knowledge of the behavior of the metals under simulated production conditions.

640290 Regenerative Turboprops Promise Endurance, Payload Hikes. P. E. Beam, Jr., R. E. Cutler, Allison Division, GMC; and J. E. Brock and I. J. Gershon, Air Force Systems Command. Regenerative turboprop engines are getting close scrutiny as potential powerplants for special-purpose aircraft. A recent study indicates that they could increase payload and/or endurance for a variety of missions. And, tests conducted by Allison have confirmed, for the first time, that the specific fuel consumption of a large turboprop engine can be substantially reduced by regenerative heating. Four aircraft configurations are compared in this study. They are equipped with:

1. In-production nonregenerative engines.
2. Advanced nonregenerative turboprop engines.
3. Regenerative turboprop engines.
4. Regenerative turboprop engines and laminar flow control on the aircraft.

640291 A Passenger Car Engine Goes to the Races. W. H. Gay, Engine & Foundry Division, Ford Motor Co. Modification of a standard Ford 260 cu in. V-8 to produce a winning full racing engine upset Indianapolis "500" tradition. An aluminum engine block and heads, revised valve train and porting, and a redesigned combustion chamber are among the changes which resulted in achieving more than twice the power of the production engine, with 25% less weight.

Rear-mounted in Lotus chassis, two of the new engines completed the 1963 Indianapolis race, and were the only cars using gasoline fuel. The

Lotus-Fords finished second and seventh.

640292 Universal or Specialized Oils for the Farm. J. D. Savage, British Petroleum Co., Ltd.; N. P. Flynn, Mobil Petroleum Co., and A. O. Pukkila, Mobil International Oil Co. In Europe and America the trend toward one all-purpose oil is being reversed as tractor designs become more complex to satisfy current demands for higher production and greater reliability.

640293 Why VW Likes Magnesium. O. Hoehne, and D. Korff, Volkswagenwerk Aktiengesellschaft. Notable advances in the techniques of automated die casting of light metals are being made at the Volkswagen plant at Wolfsburg, West Germany. Sophisticated design procedures are making the use of magnesium for highly stressed components not only practical but economical. The end result is the considerable lightening of the VW engine and transmission, with consequent improvement of the fore-and-aft weight balance of the vehicle.

The commitment of the power train to magnesium, which was dictated by the basic concept of the rear-engined car, shows many production advantages.

640294 Protective Coatings Cut Gas Turbine Corrosion. M. F. Grandey, General Electric Co. GE studies point up advantages and limitations of silicone aluminum paint, Nubelon S, and other coatings as applied to specific parts. An all-purpose coating for gas turbine engine parts doesn't seem to exist.

640295 Commercial Laser Welding Will First Be Applied to Teeny-Tiny Parts. M. D. Weisinger, General Dynamics/Convair. Laser welding is still very much in its infancy, with exciting possibilities, but also serious limitations that must be overcome before fully successful

commercial laser welding is a reality. And even here, the first commercial applications will be among the small, thin, and tiny . . . higher power applications will not come for, perhaps, 5 or 10 years.

Thus, for the immediate future, commercial applications most likely to appear are: welding very small electrical components, thin foil fabrication, welding extremely fine wires to junction points in some of the new thin films. In fact, laser welding of thin-gage metals is already being carried out in the laboratory on a routine basis, and experiments are being conducted on the use of the laser in thin-film circuitry.

640296 New Flared Tube Fitting Cuts Leakage. R. E. Robertson and W. F. Britt, Marshall Space Flight Center. Engineers at Marshall Space Flight Center have developed a new flared tube connection superior to AN types. Designated MC, it cuts leakage by a factor of 10 or more.

640297 Tin Additions Boost Gray Iron Strength. J. B. Long, Tin Research Institute, Inc. Tin is used as an alloying agent in modern foundry practice to improve the properties of gray irons. It serves, for example to promote a fully pearlitic matrix for both flake and nodular irons.

This promotion of pearlite in flake and nodular irons by alloying with tin is important to foundrymen. It produces higher and more uniform hardness values and better mechanical properties, which make for improved machinability and wear resistance of castings.

640298 Mg Alloy Use Cuts Aircraft Wheel Cost, Weight. H. C. Buckelew, Dow Metal Products Co., Division of Dow Chemical Co. Magnesium offers the designer of aircraft wheels a means of improving the product, extending service life, reducing weight, increasing performance, and reducing costs.

Each of the various magnesium al-

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loys and tempers offers definite and different physical characteristics, and the designer must make the decision as to which is best suited to specific applications. Both forgings and castings of magnesium are feasible for wheel manufacture. A new high-strength casting specification gives the designed higher minimums, particularly in the critical areas.

640299 Engineering Cars to Sell. D. N. Frey, Ford Division, Ford Motor Co. Reliability and durability are second only to styling as important parts of engineering-to-sell. So, seeking out customer usage and cross-checking with engineering test methods have to become integral parts of automotive engineering.

But the unglamorous day-to-day drudgery and toil necessary to design and prove out reliable and durable products will always be recognized as an equally important part of engineering both the objective and subjective functional characteristics of automobiles. Also product innovation, both long- and short-term, will continue to be a key to market success, especially for the more inventive and research-minded engineers.

640300 Ford Tailors Sporty Mustang to Meet Driver Specs. The Mustang has a sports-car-type body and interior, together with a choice of eight engine-and-transmission combinations. Powered by a 170 cu in. 6-cyl engine the Mustang is designed for economy of operation. Fitted with the optional 271 bhp V-8 the car is a high-performance vehicle for road or sports driving. The platform-type chassis and welded body provide rigidity with minimum weight, and are common to all versions of the car.

640301 "Coordinated Control of Decentralized Operations." Norman G. Shidle, *SAE Journal*. Alfred P. Sloan's *My Years with General Motors* is a thrilling text for any engineer wise enough to want to study the economics and the art of modern corporation management. But it has special value for members of the Society of Automotive Engineers, of whom the author himself is a distinguished and long-standing example.

The Society of Automotive Engineers is mentioned only once in *My Years with General Motors*. But many members who have contributed greatly to SAE appear as stars or featured players in the management revolution which Sloan achieved in General Motors through the most evolutionary of processes.

Charles F. Kettering, SAE president in 1918, appears prominently. The inside story of Boss Ket's frustrations in the commercial failure of his copper-cooled engine development is a highlight of automotive history for engineers in general and for SAE members in particular.

640302 Crankcase - Diversion Tactics Say Bye-Bye to Blowby. R. D. Quillian, Jr., N. T. Meckel, and J. V. Moffitt, U.S. Army Fuels and Lubricant Research Laboratory, Southwest Research Institute. Blowby can be diverted from an engine crankcase by any one, or combination, of four basic methods which are reliable and easily adapted to conventional engines at low cost.

With attainable diversion efficiencies running as high as 99%, sludge formation is inhibited, oil life is extended, with consequent longer engine life, and there is a substantial reduction in air pollution.

Blowby diversion does not reduce inherent combustion leakage. It is accomplished after the gases leak past the compression rings and before they escape into the crankcase atmosphere.

640303 Winterizing Art Gains But New Problems Develop for Arctic Machinery Operators. J. P. Gardner, Stolper Industries, Inc.; P. D. Gilson, and A. C. Paradis, Mobility Command, U.S. Army. After 20 years of intermittent development and testing of construction equipment there remain many unsolved problems which inhibit extension of operations into the polar regions. To these key problems new ones have been added by the trend in design to high-performance components requiring minimum operator effort.

The basic objectives of winterization which have yet to be fully attained are:

- Reasonable protection, comfort, and visibility for the operator, assuming that he will remain heavily clothed.
- Prompt warmup and reliable starting of equipment.
- Emergency starting help or service from any type of slave kit or from other vehicles or equipment.
- Additions or modifications to the machine to enable it to maintain internal operating temperatures high enough for satisfactory performance while retaining reasonably normal reliability and durability with minimum increase in maintenance over that required in a temperate climate.

640304 Laser - New Competitor for Drilling Tiny Holes? D. L. Williams, Advanced Technology Laboratories, General Electric Co. The day may soon come when the laser will provide serious competition for the electron beam in making tiny holes, particularly holes of high depth/width ratio, holes at an angle to the incident surface and holes in very hard materials.

The holes obtained with the laser beam, particularly those of large depth/width ratio, resemble quite closely the holes produced by elec-

tron-beam techniques—and they require considerably less setup time.

But before this occurs, we must be able to produce high-energy pulses at higher repetition pulse rates, approaching continuous operation—which means greater efficiency of laser operation. We must also have a better understanding of exactly how the holes are formed. Such knowledge, for example, will help us devise better ways of reducing or eliminating expulsion than are available today, and will teach us how to drill holes in materials of very high thermal conductivity.

640305 Blades That Breathe Up Turbine Engine Performance. S. Lombardo, N. Lauziere, and D. Kump, Wright Aeronautical Division, Curtiss-Wright Corp. Substantial gains in aircraft gas turbine performance may be derived from transpiration cooling—a technique involving turbine blades that breathe cooling air through small pores in their aerodynamic surfaces. Transpiration-cooled turbines made of conventional materials can operate with an inlet temperature of 2500 F or more, compared to uncooled turbines that are temperature limited to 1600–1800 F. The porous metal turbine blades may be fabricated from sintered wire mesh material and have been tested above 2400 F.

640306 Army Research Engineers Breed Mechanical War Horses. J. H. Kerker, U.S. Army Engineer Research and Development Laboratories. Modern warfare places very special requirements on earth-moving equipment, because of the environmental conditions and the speed at which work must be done. Equipment must be highly reliable because of the lack of repair facilities. Simplicity of operation is essential, since skilled operators are not always available. For maximum on-the-spot availability, equipment must have cross-country mobility and amphibious ability. Air transportability is highly desirable.

Realizing that mobility is an essential ingredient of success on any battlefield, the Army in 1962 established the Mobility Command (MOCOM), in Detroit, as part of the Materiel Command, to develop, produce, and procure all Army mobility equipment and supplies. The U. S. Army Engineer Research & Development Laboratories (ERDL) at Fort Belvoir, Va., one of the key MOCOM agencies, is engaged in extensive studies of earth-moving equipment and techniques.

640307 Mack Designs V-8 Diesel for Modern Turnpike Service. W. J. Pelizzoni, B. Ucko, A. Raho-chik, F. Pekar, and J. F. Greathouse, Mack Trucks, Inc. Mack's new model END864 V-8 diesel engine is capable of producing 255 hp normally aspirated, with a minimum potential of 350 hp with turbocharging. The engine meets its design goals of suitability for application to all types of road vehicles, including short cab COE's, both intercity and transcontinental buses, and military requirements. New features include a redesigned combustion chamber, larger bore, wider valve spacing, decreased engine height and length, increased displacement, maximum torque, and rapid replacement-maintenance construction.

640308 Modular Check-Out Gear Puts Zip into Missile Test. D. B. Dobson, Radio Corp. of America. The development of automatic, modularized test equipment for missile and space vehicle systems is resulting in faster check-out, less need for skilled test personnel, vastly reduced equipment needs, and simplification of related logistics problems. The use of modular components eliminates the need to obsolete support equipment when the prime equipment is modified or discontinued. The ability to rearrange the building blocks of an existing test system to suit changing or radically different test requirements decreases instrumentation lead time, while saving the cost of new test

equipment. The same components can be used for on-line testing in production facilities.

640309 A Passenger-Car Engine Goes to Sea. N. A. Newman, Marine Division, Chrysler Corp. Chrysler engineers calculated that their 225 cu in. automobile engine had sufficient power to drive an 18–30-ft pleasure boat, and could be made seaworthy with a few modifications. First, they merely laid the engine on its side. New pistons were installed. Compression ratio was changed to 8.2/1 so the engine can use a wide quality range of fuels. The plain steel core plugs in the cylinder head and block of the automobile engine were replaced with brass core plugs. The automobile valve gear was replaced with plated valve springs, stellite-faced valves, and exhaust valve rotators.

640310 Hydromechanical Fuel Controls Look Good for Mach 3. J. R. Goerke, Bendix Aerospace Division, Bendix Corp. Present evidence indicates that hydromechanical jet engine fuel controls can be designed, within current state-of-the-art capabilities, to work well under Mach 3 flight conditions. Such units are even now operating on Mach 2 military aircraft, where temperature ambients are as high as 600 F. While extension of flight speed to Mach 3 will result in 1000 F ambients, fuel temperature at the control inlet will probably be limited to 450 F due to fuel thermal stability requirements. A high Mach number control unit has already demonstrated that durability and good component accuracy can be achieved under these conditions. This was shown in endurance tests lasting up to 300 hr, where ambient and fuel temperatures were cycled from 80 to 900 F and 80 to 450 F, respectively.

640311 Low Oil Viscosity—Not High Cranking Speed—Makes Engines Start Faster. T. W. Selby,

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General Motors Research Laboratories. The best way to ease low-temperature-starting difficulties is to reduce the viscosity of the crankcase oil. Do not count on gaining much by increasing the capacity of the starting system. This advice is based on recent cold-room test results, which indicate that crankcase oil viscosity, and not engine cranking speed, is the controlling factor in starting cold engines. In fact, the test engines were successfully started at 6 rpm cranking speed when the oil viscosity was low enough; but when viscosity was too high, an engine might start, but would not continue to run, even at a cranking speed of 125 rpm.

640312 Interconnected Propellers Give French Transport STOL Capability. M. D. Marks, and A. A. Lischer, McDonnell Aircraft Corp. A true STOL aircraft has sufficient control and performance capability to assure safe, repeatable short-field operations under all conditions. In meeting these requirements, the Breguet 941 STOL transport relies on a cross-shaft system that interconnects its four propellers.

640313 Flight Plan for Apollo. C. H. Cossette and C. A. Moosbrugger, Minneapolis-Honeywell Regulator Co. Apollo's mission is a manned round trip to the moon. The mission is divided into several distinct phases. Each phase involves a specific configuration made up of appropriate major components of the lunar mission vehicle.

640314 Fuel Control Fits Many Engines. P. J. Léeson, Woodward Governor Co. Standardization could cut cost, time, and engineering effort in the design of fuel controls for turbine engines. As a step in this di-

rection, Woodward Governor Co. has designed a fuel control that can be adapted to a wide range of engine sizes by means of relatively few hardware changes.

The control has three sections—computer, governor, and fuel metering.

640315 Pulse Systems Gain Favor as Controls for Gas Turbines. B. E. Blackaby, Hawker Siddeley Dynamics Ltd. Current emphasis in design of electrical controls for gas turbine engines is shifting from pure analog systems to pulse systems. Pulse systems use frequency—in the form of square waves or pulses—as the analog of the control parameters. The amplitude of the pulses is relatively unimportant.

640316 Failure Studies Help Engineers Predict Jet Engine Reliability. G. Reethof, General Electric Co. Jet engine reliability prediction involves two types of analysis—deterministic and probabilistic. The deterministic part of the analysis identifies all the ways each part can fail and determines the consequences of these failures. The probabilistic part establishes the probability of failure for each part in each of its failure modes.

640365 Quartz-Iodine Headlamps Slated for European Debut. V. J. Roper and L. A. Morgenstern, Miniature Lamp Department, General Electric Co. Quartz-iodine incandescent lamps will be used as light sources in a new 4-unit headlighting system soon to be introduced on European cars (Fig. 1). These lamps give more lumens per watt than conventional bulbs now used in European headlamps and will raise average

light output of European lower beams approximately to that of the U.S. standard sealed beam lower beam.

640366 Spaceport Spawns Superlatives. A. H. Bagnulo, John F. Kennedy Space Center, NASA. The U.S. manned lunar landing program is one of the largest and most complex tasks ever undertaken by man. The enormity of the project is perhaps best illustrated by the lunar space vehicle—the Apollo/Saturn V—which weighs 3000 tons and measures 362 ft from nose to nozzle. Complexity and intricacy, too, are embodied in this huge rocket whose components must function with watch-like precision.

640367 Chrysler's Auto Turbine Travels the Long Road Home. The development of a gas turbine engine suitable for passenger-car use presents many complex technical problems in relatively unexplored areas. Chrysler engineers faced the task of producing components in the small sizes required for automobile use with efficiencies equal to those being obtained in large engines. It was necessary to build a highly effective heat exchanger with low pressure drop. Low cost, high-strength, heat-resistant materials were a mechanical and economic must. Also flexibility of operation, low noise level, adequate engine breaking, and reasonable gas generator acceleration time were required. Exhaust gas temperatures had to be low, and the engine had to be light, reliable, and easy to maintain. From the cost aspect, an automobile turbine would have to be competitive with conventional reciprocating engines.

640368 Continuing Education Ultimately Up to Individual. "Intellectual growth and professional development are very personal things. They are ultimately the individual's own responsibility and that of his immediate professional surroundings."

This concept emerged as basic in

recent SAE-sponsored explorations of industry and collegiate potentials in continuing the education of engineers.

640369 From Seat on Platform to All-Embracing Shell Traces Forward Leap of Body. V. D. Kaptur, Jr., General Motors Corp. Current design began when buggy influence was shed and passenger and engine compartments were united. Complete envelope evolved as car bodies were widened and lengthened, with integration of components.

640370 So You're Thinking of Buying Business Aircraft. M. H. Smith and H. P. Schmidt, R. Dixon Speas Associates. Selecting business aircraft in a rational manner is a 3-step operation.

First, determine and define specific travel requirements with respect to use of the prospective aircraft.

Then examine and compare various aircraft to determine the capabilities and characteristics of each with respect to the defined requirements.

Finally, match the requirements to be fulfilled with the aircraft available to evaluate and reach a final decision and selection.

640371 Value Engineering - 6 Techniques Illustrated. A. J. Wojtowicz, Eclipse-Pioneer Division, Bendix Corp. Thirteen ways have been developed to identify costs, overcome obstacles, and achieve best alternatives. Case histories illustrating six of the thirteen are given.

640372 Guaranteed Performance Marks Advance in Insulated Trailers. G. Chieger and K. W. Tantlinger, Fruehauf Corp. The design and performance of insulated trailers have been improving steadily, and now, for the first time in the history of refrigerated transportation, a test method permits a reliable prediction and even a guarantee of performance.

640373 Buick 300 Transmission

Sheik to a Harem of Engines. C. S. Chapman, Buick Motor Division, General Motors Corp. New automatic transmission combines a variable-pitch torque converter with a 2-speed gearset to provide 3-speed performance. Unit is easily adaptable to a number of engines.

640374 False Warning Riddance Sought in Air Fire Detection. False warnings are the most costly, aggravating, and hazardous malfunction of aircraft fire detection equipment, aeronautical engineers seem to agree.

Failures can be prevented - or at least greatly reduced - detection system vendors say, by recently improved installation and maintenance practices. Most of the system failures, it appears, are due to moisture, vibration, abrupt stress reversal, saline conditions in the atmosphere, deterioration of rubber grommets, and electronic relays . . . or to mechanical failures caused by fatigue of metals.

640375 Beryllium and Fiberglass - New Gas Turbine Lightweights? D. B. King, Brush Beryllium Co.; J. D. Marble, Flight Propulsion Laboratory, C. H. Conliffe, General Electric Co.; R. J. Beck, and R. M. Gabel, Continental Aviation and Engineering Corp. Materials research and development programs concerned with gas turbine engine improvements are upgrading the mechanical properties of beryllium. Engine-testing is proving the possibilities of fiberglass reinforced plastics as a material for compressor blades and stators. Efforts are directed at producing smaller, more efficient transonic compressors for turbine engines in the 25-300-hp range. Results to date are encouraging.

640376 Strengthened Thermoplastics Bid for Body Applications. T. P. Murphy, W. H. Chadbourne, Fiberfil, Inc.; and R. C. Petersburg, U.S. Rubber Co. Thermo-

plastics can be strengthened by reinforcement with fiberglass or by incorporation into a laminated sandwich structure. Materials created by both these processes have been used in automobile and truck body applications for several years. More extensive use may be in the offing.

640377 Quick Starts Simulate Crash Stops in GM Collision Research. L. C. Lundstrom, A. H. Kelly, Jr., GM Proving Ground; and D. J. LaBelle, Truck & Coach Division, General Motors Corp. The impact sled, a full-scale laboratory tool which simulates vehicle accidents, is being used by General Motors test engineers for studies ranging from complete vehicles with passenger dummies to single components, such as seat belts and door locks. The indoor facility is independent of weather conditions, permits rapid sequencing and scheduling of tests, and is far less costly than barrier impact testing. It does not replace fully other types of crash testing, but rather augments them through single component tests.

640378 Endurance Tests Boost Part Life - Slash Warranty Costs. R. P. Keller, Engineering Staff, Chrysler Corp. Experimental stress analysis complemented by life testing, plays a vital role in the design and development of brake and suspension components. Testing techniques to provide rapid evaluations are employed on a variety of structural members. The application of simple principles with regard for limitations provides solutions to many endurance problems and increases reliability. In the automobile industry reliability means trouble-free motoring for the driver . . . and low warranty costs for the manufacturer.

640447 Dymnt on the SST. J. T. Dymnt, Air Canada. Both the aviation industries and the governments of the United States, England, and France are facing the technical-financial problems of the supersonic trans-

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port. Many of these problems as yet have no answers—or are being answered in so many different ways that they, in effect, remain unanswered. For this reason the authoritative thoughts of SAE President Jack Dymment on the status of the SST are presented here. Not all questions about the plane can be answered at this time, but Dymment's answers provide much solid thought and many worthwhile ideas.

640448 Lycoming-S&H Multifuel Engine Developed for Army Is Light and Simple. P. H. Schweitzer, A. W. Hussmann, Schweitzer and Hussman Engineering Office; and A. E. Sieminski, Lycoming Division, AVCO Corp. The Lycoming-S&H 2-stroke, air-cooled, loop-scavenged, multifuel engine developed for Army combat vehicles is:

- Light as a gasoline engine—being made mostly of aluminum.
- Simple as a lawnmower engine—with only three principal moving parts: piston, connecting rod, and crankshaft.

To achieve these and other important features required 10 years of development. During this period many important design problems were investigated, some of which were solved rather easily, and others not so easily.

640449 Accuracy Measured in Millionths Tracks Down Machining Errors. R. W. Militzer, Micro-matic Hone Corp. Precise determination of roundness, concentricity, sphericity, and perpendicularly is a critical factor in the achievement of product reliability. Several techniques are now in use, the most promising of which is that of radial comparison to an ultraprecision spindle. This sophisticated gaging technique is being employed to evaluate ma-

chining methods and solve manufacturing problems.

640450 Advances in Telemetry Open New Roads to Testing. O. E. Kienow, Tucson Engineering Laboratory, Hughes Aircraft Co. The earthmoving industry is on the eve of a new era in laboratory and proving ground testing of its products. Advances in telemetry have produced techniques for the observation of phenomena hitherto not amenable to mensuration. They have also made possible the monitoring of phenomena with greatly increased accuracy of measurement.

In its broadest sense, and in the sense used here, telemetry encompasses sensors which sense or measure a quantity or event, equipment which transmits the sensed or measured, and equipment which displays or records that which was sensed or measured in analog or digital fashion at a remote location.

Of perhaps particular interest to the earthmoving industry are two types of sensors—the magnetoelectric and the Hall generator.

640451 LFC Cuts Wing Friction Drag for Greater Range. W. L. Collins, W. A. Monahan, Jr., Norair Division, Northrop Corp.; D. L. Getz, Aerospace Systems, and F. B. Wallace, Jr., AiResearch Mfg. Co. of Arizona. A drag reduction system which could extend the range of various types of aircraft 20–65% is now deemed practical, since it has been successfully incorporated in an experimental plane, the X-21A. The system employs laminar flow control to eliminate as much as 80% of the wing friction drag during cruise. It differs from other boundary layer control schemes, which use suction or blowing to increase lift for better takeoff and land-

ing characteristics and are not designed to improve cruise performance.

640452 Enlarged Tomorrows Challenge Earthmoving Engineers. H. S. Eberhard, Caterpillar Tractor Co. Horizons are widening for engineering achievement in the earthmoving industry. Need for creative technical thinking and action is great. The opportunities for highly trained and modernly educated young engineers are growing every year.

Road building, for example, is destined for continued major expansion, as well as gigantic earthfill dams.

640453 With Acrylic Auto Finishes—What's Underneath Counts. A. S. Kasper, Engineering Staff, Chrysler Corp. A profilometer peak counter measures surface roughness peak height in microinches, and matte density in number of peaks per inch. An image clarity measuring device provides an evaluation of painted surface finish quality. Used together, these two pieces of equipment establish the relationship between the visual appearance of painted surfaces and the surface texture of the underlying sheet metal. Grain size can determine the difference in surface texture from the as-rolled to the finished stamped condition. Control of sheet metal texture from mill to paint shop results in improved overall finish appearance.

The objective of the test program described here was to determine the best combination of peak height and density needed to obtain optimum final painted surface quality.

640454 Stable Energy Levels Mean Better Welds for Microcircuitry. C. R. Sargeant, General Electric Co.; and P. San Clemente, Sippican Corp. The strength of welds in miniature and microminiature circuitry can vary greatly with the type of interconnect material used and with energy variations of the weld

equipment itself. The multiple-pulse power supply, however, appears to offer significant improvement in energy stability and weld strength for a variety of materials.

640455 Combat Vehicle Power - Where Needed and How Much.

H. L. Hayter, and M. Gilvydis, U.S. Army Tank-Automotive Center. To determine the power requirements of a combat vehicle which has to meet the military's concept of satisfactory mobility, field tests have been conducted with a test rig tank.

Specifically, the information sought was:

- What are the cyclic power demands when undergoing quasi-combat mobility operations?
- How much of the time is the engine operating under varying part-load versus full-load conditions?
- How much of the operation is steady-state versus transient?

This information is much needed by engineers developing military vehicles and it is not spelled out in the categories established by the military for mobility evaluation. These categories are known as "battlefield day" and "cruising range."

640456 No Noise But the Wind.

J. R. Thomson, Chrysler Engineering Proving Grounds; W. K. Bodger and C. M. Jones, Ford Motor Co. Wind noise occurring when car windows are closed is caused mainly by air leakage; aerodynamic shape is a minor factor. Since improved fresh air ventilating systems and increased use of air conditioning are leading to more driving with windows closed, reduction in wind noise becomes more important. This can be accomplished by paying closer attention to door and window seals.

Wind throb, a similarly objectionable phenomenon, occurs in most cars at certain speeds when one window is open. This pulsating pressure, felt mainly through the ears, can be effectively eliminated by employing the technique known as bearding.

640457 Get Ready to Lick New Machining Problems. N. Zlatin, and L. A. Nienaber, Metcut Research Associates, Inc. As new automotive designs are developed, especially the turbine, the materials likely to be used in their production will create machining problems harder to cope with than any hitherto met.

Both high-strength and heat resistant alloys are difficult to machine, and the more difficult they are the more critical must be the selection of machining conditions. Only a very limited range of cutting speeds, feeds, tool geometries and materials can be combined to produce a satisfactory result.

640458 Man-Made Seal Materials Challenge Natural Rubber for Tough Jobs.

B. C. Vandermar, Acadia Synthetic Products Division, Western Felt Works; and R. W. Malcolmson, E. I. duPont de Nemours and Co. The following categories of elastomers can solve approximately 95% of seal applications on heavy earthmoving equipment and other wheeled vehicles:

1. Nitrile rubber - is the most widely used seal material.
2. Polyacrylates - this category now includes polymers other than the Hy-car PA.
3. Silicone rubbers - are the only important commercially used elastomers to have an inorganic backbone to the polymer chain.
4. Fluoroelastomers - among the newest of the elastomers, have an organic backbone (a chain of carbon atoms) with the remainder of the molecule consisting largely of fluorine atoms.

Special problems sometimes require the use of other types of elastomers. Among these is neoprene, which combines outstanding weather resistance with moderate resistance to oil, good strength, and toughness. Urethanes generally have good oil and weather resistance, outstanding toughness, and high abrasion resistance.

640459 Squeeze Play by Chrysler

Puts Big Engine in Compact Cars. W. L. Weertman, and E. W. Beckman, Chrysler Corp. In designing a V-8 engine for the Valiant and Dart compacts, various goals had to be considered based on engine weight, performance, fuel economy, reliability, ease of manufacturing and service, the physical environment into which the engine would be placed, and flexibility for future design development. The overall dimensions had to be such that the new engine would fit in the Valiant and Dart engine compartments. The engine had to be light enough so that it would not have an adverse effect upon the ride and handling characteristics of the two cars. New casting techniques were employed in the major castings which enabled an overall weight reduction of 50 lb under that of the present 318 cu in. engine.

640460 In-Flight Tests Double for Wind Tunnel Studies.

D. J. Long, Aero Commander Division, Rockwell-Standard Corp. Bypassing a costly program of high-speed wind tunnel investigation, Aero Commander subjected its model 1121 Jet Commander to a full scale in-flight test program. The program consisted of 35 hr of flight time and was pre-planned so that all data were compiled in about 18 days. (Reduction and evaluation of the data took considerably longer than 18 hr, even with the help of an IBM computer). Procedure and instrumentation methods aimed at maximum overlap of all data points to be monitored, using a minimum of instrumentation.

640461 Labrador "Deep Freeze" Doesn't Chill Vehicle Performance.

N. H. Carr, D. D. Marston, A. Bauer, and D. Stanyer, Iron Ore Co. of Canada. Equipment used for strip mining in Labrador, where temperatures are below freezing for eight months of the year and -40 F for extended periods in February, requires special materials and operating techniques to prevent premature failure.

The sharp fall-off in impact strength

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of carbon steels, for example, has posed a problem that is being met by using high strength alloys, castings instead of forgings, and better structural designs.

640462 Choosing Equipment for Overseas Jobs. L. G. Wilder, Jr., H. B. Zachry Co. Contractors employing heavy construction equipment on overseas jobs must select the right units at the outset. After paying import duties, which may run as high as 200%, and transporting the equipment by sea and over miserable roads into remote areas, there is no changing what has been purchased if it is unsatisfactory. It must be made to work somehow, some way.

640564 Get to Know Reliability Control. J. de S. Coutinho, Grumman Aircraft Engineering Corp.; L. Levy, Aerospace Corp.; and F. E. Marsh, Airplane Division, Boeing Co. Some degree of failure in aerospace equipment is admittedly made inevitable by the demand for unprecedented performance and development schedules. Innovations in materials, processes, and design complexity that have become necessary to do a job at all have made it practically impossible to do a job perfectly.

If absolute reliability is unattainable, the level of reliability that can be attained in a given situation would be useful information. If a reliability analysis shows a system to be inadequate, more reliability can generally be bought . . . and paid for in terms of cost, weight, size, safety, storage life, producibility, maintainability, spares support, or performance. That is why the military is leaning increasingly on the practice of imposing quantitative reliability requirements on prime aerospace con-

tractors. In fact, industry in general is adopting such practices.

640565 Disc Brakes, Favorite of Europe, Are Orphan Child in U.S. R. C. Parker, T. P. Newcomb, Ferodo Ltd.; J. L. Winge, Auto Brakes, Bendix Corp.; and A. E. Samson, Ford Division, Ford Motor Co. Disc brakes, developed on the race track, are offered as standard equipment on many European sport and passenger cars. American manufacturers say that disc brakes are fine for racing cars and the light European passenger autos, but are, as yet, unsuitable for the heavier U. S. product. Mercedes-Benz disagrees and uses discs on the 6500-lb "Grand Mercedes" limousine. Research and development efforts concerned with disc brake systems strive for better materials, improved cooling, greater sophistication in component design and system arrangement, increased durability, decreased manual pedal effort, and lower production costs. Detroit's laboratories, with an eye to the future, are studying and evaluating disc brakes designed for U. S. cars. Results are encouraging for the discs.

640566 Particulate or Photochemical - It's Still Smog! Leonard Raymond, Socony-Mobil Oil Co., Inc. The control and elimination of smog presents a challenge to several technologies. Investigation of causes, and methods for reduction or elimination, are receiving much attention in Southern California and Detroit. New exhaust and crankcase emission control devices are being evaluated in terms of effectiveness and cost. The State of California has set up standards for the degree of contamination permissible with gasoline-powered vehicles, and set up the machinery to

make the use of anticontamination devices compulsory on automobiles, as satisfactory devices are developed and certificated.

640567 Ford Develops New Technique for Truck Frame Test. R. Z. Beauvais, and G. R. Sorenson, Ford Motor Co. FM tape recorders and servo-hydraulic actuators provide a means for the experimental engineer to supply the designer with more accurate original design information and for the performing of better qualification tests on the resulting component.

Ford's application of these new techniques to truck frame testing was prompted by doubts regarding traditional in-house design and testing. The factors thought to need re-evaluation were the adequacy of design factors of safety, the usage events producing highest frame stresses, and the correlation between the truck durability route and a selected "typical" customer's experience.

640568 Minimum SST Safety Goal: One Fatal Accident in 500,000 Hr. J. Lederer, Flight Safety Foundation, Inc. On no vehicle except space capsules has safety attention been so strongly focused by so many organizations prior to construction as with the SST. But there can be a large gap between what we know should be done and what actually is done to prevent accidents. The SST goal of one fatal accident per 500,000 hr, about equals the present noncommunist world jet fatal accident rate. Despite 1,000,000 hr of military experience and several thousand hours of civilian proving runs for jets before carrying passengers, there have been 30 fatal jet accidents and 40 total losses worldwide since 1958.

Proving runs for certification and en route qualifications, as conducted in the past aren't good enough to start SST operation at a rate of one fatal accident per 500,000 hr.

Inadequacy of ground support, responsible for some jet accidents, needs

correction to meet SST requirements for reliability.

640569 Why Doors Spring Open During Crashes. A. G. Gross, University of California at Los Angeles. When a car crashes, its door latches are subjected to many forces, some quite strong, which may break the latch or cause it to spring open. At UCLA, laboratory tests, full-scale collision experiments, inspection of vehicles wrecked accidentally, and engineering analysis have produced some important information about these forces.

640570 High Power and Endurance—Prime Needs for Spacecraft Auxiliaries. W. E. Crane, Martin Co.; R. L. Robinson, and W. U. Roessler, AiResearch Mfg. Division, Garrett Corp. It is now possible to predict which nonpropulsive power system will be used with which spacecraft during the next few years. Mission requirements are pretty much spelled out for that time period; and we know that battery, solar-cell/panel-battery (photo-voltaic), and fuel-cell systems are (or soon will be) off-the-shelf items.

Beyond 1970, it is harder to predict. The trend is toward higher power levels for longer time periods to accomplish missions. But both need and supply are subject to many variables, and a broad spectrum of power systems is being studied . . . including mechanical, thermoelectric, thermionic, and isotopic. In the realm of long-duration dynamic power systems, studies show that a Brayton cycle system can be used where radiator area is not a prime consideration. Because it uses inert gas as a working fluid, it eliminates many of the development problems of the Rankine cycle.

640571 Construction Units May Be Down But Not Out. G. S. McGrath, Michigan Tractor & Machinery Co. No two contractors or owners of construction equipment have iden-

tical standards of what constitutes acceptable service life. But from the varied opinions expressed by those who have to make the decision when to replace equipment, certain conclusions can be reached:

- Acceptable service life of a machine is that period of time in which unit cost of production is in line with costs which can be obtained from new equipment.
- For a machine or part it is what is acceptable to the owner rather than the mechanic or operator.
- It is that which compares favorably with the standard for the industry and the application.
- For a wearing part it is governed by application and cost.
- For a machine or component it is that life in which full value or benefit is derived from the design.

640572 Multiple-Chamber Unit Improves Muffler Silencing. J. C. Walker, and E. C. Lentz, Exhaust Systems Group, Walker Mfg. Co. Chassis configuration usually limits muffler location. Analysis indicates more efficient silencing is possible if small-diameter acoustic elements are placed at several locations along exhaust pipe.

640573 Pick the Right Truck for the Job and Save Dollars and Headaches. J. H. Humpton, Jr., Mack Trucks, Inc. Medium and heavy truck applications can be divided into three basic categories: highway or intercity service; intracity service; and dumper-mixer service. A subcategory includes emergency vehicles. Considerations based upon required use include: dimensions, user preference in regard to configuration, power train, axles and springs, and frame section and construction. The factors dictating the design or configuration of a truck chassis are common to all trucks. The importance of each factor varies with the intended usage of the truck.

640574 Guideposts to Keep

Thermocouple Users Out of Hot Water. Many factors must be considered before selecting a thermocouple for a particular application. Every case is an individual one and must be judged on its own merits. However, a comparison on the basis of temperature limitations, thermoelectric output, thermoelectric power, stability, and mechanical properties offers some rough guidelines for potential users.

640575 Car Engines Ride the Waves. H. R. Fortgang, Dearborn Marine Engine Division, Eaton Mfg. Co. To overcome the excessive cost, size and weight characteristics of old-line, inboard marine engines, Dearborn has constructed its line of Interceptor powerplants from basic Ford passenger-car-engine components.

Other advantages stemming from the use of high volume, proved automotive components have been: an increase in the hp/lb ratio; high hp and torque outputs per cu in. displacement; a lower vertical silhouette (height from crankcase centerline to highest point on engine); and reliability equal to or better than old-line engines.

Marine engines operate under conditions unlike those met by passenger-car engines and their design must accommodate for these conditions as well as for differences in installation.

640576 Cryogenics Squelch Quench Distortion. E. Dullberg, Grumman Aircraft Engineering Corp. Use of liquid nitrogen instead of water as the quench medium in heat-treatment permits the production of distortionless and residual-stress-free parts from aluminum alloys.

Aluminum sheet metal parts as thin as 0.016 in. or less can be formed in the "O" condition and heat-treated to maximum strength without fear of quench distortion. This should give designers greater freedom.

640603 Designing Vehicle Seats for Greater Comfort. J. J. Keegan,

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M.D., College of Medicine, University of Nebraska; and A. O. Radke, Bostrom Corp. The design of automobile seats can be greatly improved by applying recently obtained medical knowledge about the causes of backache. Medical experience with more than 3000 patients and several scientific studies suggest that when a person sits with his back straight and at right angles to his legs he is very likely to be uncomfortable. In this position pressure is put on the intervertebral cartilaginous discs of the lower spine and may cause them to protrude or even slip out, particularly after 30 years of age, when they are losing their elasticity.

A much better sitting position is inclined slightly backward so that the legs and trunk make an angle of about 115 deg and the spine can fall into its normal curved shape.

640604 Sintering and Savings Can Be Synonymous. L. Alexander, Haller, Inc. Powder metallurgy offers the design engineer a completely integrated manufacturing method, and the greatest savings in production cost will accrue when the following conditions prevail:

- Production is in reasonably large quantities.
- Individual forgings or castings require considerable machining.
- Ratio of finished to starting weight is low.

The economical size limit for parts at the present time is a projected area of 30 sq in. and a height of 3 in. Tolerances vary with part size and complexity but, generally speaking, pressing, sintering, and sizing operations set a limit of 0.002 in./in. on radial dimensions and three to four times as much on axial dimensions.

640605 Dollar Dilemma Threatens SST. R. K. Rourke, Trans World

Airlines, Inc.; and J. P. Mitchell, Chase Manhattan Bank. Goaded on the one side by the joint British-French SST venture, the Concorde, and on the other by a commitment to technological achievement, the U.S. aircraft industry expresses its almost heretical fear of the SST mainly in apologetic tones. It is not fear of incompetence . . . there is hardly a doubt that such a plane can be built. What has the industry worried is the crushing cost of development—all for an uncertain market—and the questionable economics of SST operation.

These economic problems would evaporate, of course, if the government decided to foot the entire bill. But besides being unlikely, this situation would be unhealthy. Cost sharing by industry is essential for establishing the checks and balances needed to assure the most effective use of the government's funds. It would also provide an incentive to be right the first time when it comes to the decision making process.

640606 Thin Films: Dark Horse in Electronic Packaging. R. P. Radke, Space Technology Laboratories, Thompson Ramo Wooldridge, Inc. The techniques being developed for thin-film circuits are summarized, along with some of the reasons why this form of electronic circuit construction is expected to find wide application, even though it may never be able to provide the extreme miniaturization possible with integrated circuits diffused into single silicon chips.

640607 Ford's DOHC Competition Engine . . . From Fairlane to "Indy" Lane. A. J. Scussel, Engine & Foundry Division, Ford Motor Co. Ford Motor Co.'s second-generation Indianapolis-type competition

engine utilizes many components and design features of the 1963 push-rod engine and adds double overhead camshafts, fuel injection, double exhaust and intake valves, a 12.5/1 pent-roof combustion chamber, heavy-duty pistons and rods, and an enlarged lubrication system. Design was accomplished in three phases, tested on dynamometer and track, and proved at the Indianapolis "500."

The performance of the 1963 engine in competition indicated that greater horsepower and torque were essential to continuing success in the 225 cu in. racing class.

640608 Need Info PDQ? EDP Can Give It! S. I. Greenberg, Republic Aviation Corp. The increasing sophistication of parts and assemblies in the missile-aerospace industries demands equally sophisticated manufacturing control. Electronic data processing (EDP) techniques are being used to automate a variety of production control functions. High-speed information generation is a valuable management tool for cost control.

640609 Air Cargo Rolls Faster. J. L. McLellan, Air Canada; and J. J. Healy, Flying Tiger Line, Inc. The basic air cargo problem is to advance ground handling and processing systems and equipment to match the technological developments in aircraft design. All too often it takes longer to handle cargo (and passengers) on the ground than to transport it to its destination. And the situation will worsen with the advent of the supersonic aircraft.

There are many facets to the basic problem. One is how to speed up handling when the cargo is mixed passengers and freight. Another is how to develop or alter commercial airline systems to be compatible with the military 436L system.

640610 Army Looking for Big Abilities in Small Battlefield Vehicles. F. B. Lux, U.S. Army Tank Automotive Center. The combat vehicle of the future must be less tied to

complex fuel supply systems. It must be more agile and transportable, operate over a wider range and for longer periods of time. And it must be ready for instant operation and be trouble-free.

This tall order has a direct bearing on engine development because success of the vehicles hinges upon the power units.

While vehicle trends shape components, they are, in turn, modified by the technical limitations of the components. Therefore, the engine requirements projected here represent the optimum compromise between what is desired of combat vehicle engines and what is considered to be technically feasible.

640611 New FRP Is a Smoothie. C. A. Sprang, and G. I. Davis, Cimatra Division, Cincinnati Milling Machine Co. Fiberglass-reinforced plastic automotive parts are now being produced which show only 25 microin. in roughness and 450 microin. or less in overall fine waviness of the surface in the unsanded state.

In addition to featuring a surface quality that promises substantial reduction in finishing costs for parts to be painted, the physical properties are superior to those of recognized automotive grade FRP containing 40% glass.

640641 Frequent Take-Offs and Landings Increase Operating Problems of Medium-Range Jets. W. E. Rhoades and R. T. Glassons, United Air Lines, Inc. Medium-range jets have more operating problems than long-range jets because they go up and down more often. United's average Caravelle flight lasts 70 min. As a comparison, a DC-8 flies about 2½ hr before it is again subjected to delay or cancellation. However, despite the short flights of the Caravelle, it has achieved almost 97% reliability over a 12-month period. But it did not start service at this high level of reliability. During its first six months of operation, it averaged six mechanical delays or

cancellations for each 100 departures.

640642 Looking at the Trouble Spot Where the Rubber Meets the Road. W. E. Meyer, Pennsylvania State University. Emergency stopping ability of cars is limited by degeneration of the frictional bond between tires and pavement whenever the road is wet. Hydrodynamic effects can produce planing at speeds as low as 30 mph; and adhesion is reduced, down to the lowest speeds, by the presence of even a thin water film on the pavement surface. Measuring equipment is being used to determine the skid-resisting characteristics of various types of pavement. Since a sliding tire acts much like a series of rubber blocks, this similarity is used to study the change of skid resistance of tires with wheel load, sliding speed, and inflation pressure. The escape of water from under the contact area depends on both the tire grooving pattern and the escape channels in the pavement material.

640643 Performance Trials Do Tell A Significant Story. A. W. Percy, W. A. Forrest and G. A. Olson, Pure Oil Co. Research Center. Data accumulated by the Pure Oil performance trials make plain what every consumer should know, that:

- As horsepower and weight increase, economy decreases.
- Manual control is slightly more economical than automatic shift.
- Acceleration is influenced more by number of cylinders than by weight and horsepower.
- Brake design can be coupled with car weight.

640644 American Motors Puts A New Straight Six In Ramblers. D. V. Potter, G. F. Leydorf, Jr., and R. L. Lawler, American Motors Corp. American Motors has a new 6-cyl engine for the Rambler line. The engine features overhead valves, a 7-bearing crankshaft, modification flexibility, crankcase emission control, new manifold, and increased power and torque. The in-line con-

figuration was chosen after testing V-6 designs on the basis of smoother operation and lesser cost. The design and test processes emphasize durability, smoothness, and quietness over the full range of operating conditions, and economy of operation and manufacture.

640645 Improved Hydraulic Systems Seen For Future Aircraft. Cooperation and research will combine to perfect hydraulic systems and their fluids in future jet and supersonic aircraft. Cooperation between aircraft manufacturers, hydraulic systems producers, and airlines already has resolved many problems during jet aircraft integration into commercial operation. But future reliability gains are seen coming from recognizing that little details cause many serious hydraulic system problems. In these details, there is vast room for improvement, and the industry is in the process of providing a healthy research climate in which good ideas for solutions can grow and bear fruit.

640646 Supersonic Commercial Jets Need Low-Cost Fuel. E. H. Wehner, Flight Propulsion Division, General Electric Co. Some of the fuels now being used by commercial jets could be used in supersonic transport engines. Their thermal stability characteristics can be improved by additional processing, or by the removal of oxygen and, perhaps, by the use of additives. These findings are important. Fuel will account for an estimated 40-50% of the direct operating cost of a supersonic transport aircraft, and if such transport is to be economically feasible it will be necessary to use present-day commercial aviation kerosene or fuel of equivalent cost.

640647 Power Up, Size and Weight Down on Oldsmobile F-85 Engine. G. Burrell and F. W. Ball, Oldsmobile Division, General

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Motors Corp. A new engine, designed to power the Oldsmobile F-85 compact line and the Jetstar 88 series of full-size cars, utilizes some interesting weight and cost saving design features. Changing the valve angle decreased the size and weight of cylinder heads. Unusual location of intake and exhaust valves permits the use of shorter and lighter manifolds. These and other measures add up to a saving of 154 lb.

640648 How To Determine Formability of Low Carbon Steel Sheet and Strip. The material in this article is drawn from the newly issued SAE J877 Information Report "Properties of Low Carbon Steel Sheets and Strip and Their Relationship to Formability." The report was prepared by Division 32, Carbon Sheet and Strip Steel, of the SAE Iron and Steel Technical Committee.

640649 Improving Truck Ability Prediction Data. J. W. Anderson, J. C. Firey, P. W. Ford and W. C. Kieling, University of Washington. Some improvement in the accuracy of truck performance procedures, presented in the SAE Technical Report, HS 82, might be gained by using data from a wider variety of vehicles, specifically by including data from trucks of heavier weight. This is suggested by studies conducted at the University of Washington wherein the HS 82 procedure was used, following by direct measurement of vehicle drag forces. While there was approximate agreement between HS 82 estimated values and the measured values, there are some differences worth noting.

640650 Is There Life Beyond The Blue? S. M. Siegel, Union

Carbide Research Institute. Laboratory experiments have been conducted to determine if complex organisms—seed plants, invertebrates, and fungi, for example—can withstand the factors of the Martian environment, singly or in combination. These experiments reveal that the inherent capabilities of living matter which has been shaped by the environmental history of this planet, are far wider than could have been anticipated. Further, that some cherished teachings about "fit" between organism and environment must be re-examined.

640651 Man On Bicycle Symbolizes Power In Undeveloped Lands. R. C. Hamilton, Res. & Engrg. Support Division, Institute for Defense Analyses. Where portable power systems are needed for short-mission radio in undeveloped areas, reliability and light weight are the primary needs. This makes the rechargeable battery most desirable. For missions of longer duration, a foot-powered generator with rechargeable battery is most attractive. For stationary systems, where the total operating cost over a 5-year period is the primary consideration and weight is of less moment, the best power source is a foot-pedaled generator-charged automobile-type, lead-acid battery. These conclusions were reached through analysis of a wide variety of possible portable and stationary power sources for regions where liquid hydrocarbon fuels are not readily available and charcoal or wood is preferred.

640652 High-Temperature Alloys Need Overcoats. E. S. Nichols, J. A. Burger, and D. K. Hanink, Allison Division, General Motors Corp. A search for better

coatings for the protection of metal parts in high-temperature oxidizing environments has led to many recent developments in aluminum-base diffusion coatings as well as with other coating materials. Many of the newer pack diffusion coatings employ aluminum with other elements such as chromium, silicon, iron, and nickel. The constituents diffuse into the base alloy and form alloy systems of varying composition from the surface to the limits of the diffusion. This results in a tenacious coating that does not chip easily.

640653 Better Equipment, Simpler Methods Widening Air Cargo Future. Standardization of handling equipment and simplification of international licensing procedures are major factors in air cargo growth. Limited understanding of industrial distribution needs and costs has been a barrier to even greater expansion. In 1963, the world's scheduled airlines flew 2.28 billion ton-miles of air freight—an increase of 14% over 1962. In the short space since 1950, world air freight traffic has increased four times. International and domestic air cargo of the U.S. increased about 3.5 times; Canada 7 times; Australia 2 times; United Kingdom 5 times; France 4 times; and Brazil 3 times.

640654 Tests Speed New Uses For High-Frequency Welding. H. B. Osborn, Jr., Tocco Division, Ohio Crankshaft Co. High-frequency welding is being applied to an ever-widening variety of applications, including a number in the automotive field. Production use is still relatively limited, but successful pilot operations are numerous. Materials welded include steel, cast iron, titanium, brass, aluminum, copper, nickel and special alloys. (Low-cost aluminum furniture of welded aluminum tubing—and welded copper tubing—are both possible now because of high-frequency welding development.)

640655 Travel Trailer Towing

Improved By Trailer and Car Designers. Work is continuing on every trailer design parameter to improve the relationship between the trailer and the car. Trailer manufacturers and hitch makers are realistic about the possibilities of major car changes to accommodate towing needs. They recognize that good trailer design, rather than modifications in car design, have to provide the major improvements in towability. Reduction of tongue loads by better distribution of trailer components, better aerodynamic characteristics for improved fuel economy, and good battery location are all examples of advances being incorporated in many trailer designs.

640656 How Clean Is Clean? D. A. Eckhardt, Radio Corp. of America; C. T. Williamsen, Grumman Aircraft Engineering Corp.; and P. R. Austin, USAF. How clean should a clean room be to satisfactorily produce a particular product? The answer to this problem has been a source of constant confusion to both industry and the government. So they decided to do something about it. Working together, industry and government have developed a new specification which standardizes definitions and environmental controls of clean room operations. The new Federal Standard 209 goes a long way toward "clearing the air." The level of cleanliness required for a specific operation directly affects the construction, and therefore the cost, of clean room facilities. Clean enclosures can vary from the simple "clean work" station to the complex ultra-clean "vertical laminar flow" room.

640657 Designers Propose to Alleviate Varied PTO Application Problems. G. S. Park, Body & Hoist Division, Heil Co.; W. H. Buelow and E. C. Thayer, Rex Chainbelt, Inc.; T. E. Kartisek, M-D Blowers, Inc.; W. A. Eskridge, Tel-E-Lect Products, Inc.; J. R. Albright, Roper Hydraulics, Inc.; O. E. Potter, Worthington Co. Better coordination of

vehicle design with power-take-off requirements is needed to alleviate current application difficulties, equipment makers agree. The application problems are different on dump trucks, truck mixers, utility and commercial construction units, for pneumatic conveying, fluid transfer pumping systems, and air compressors. But in every instance, better performance and lower costs might result from advance design coordination between vehicle, transmission, and pto manufacturers.

640658 Intransit Cargo Control Dire Need For Jet Age. V. F. Caputo, Office of Secretary of Defense; and L. Miller, Lionel Miller & Associates. The only justification for air cargo transport is speed. If cargos stagnate in terminals, the high value of speed is largely dissipated. When jet freighters tug at their leashes while shipments move at a snail's pace, airlines lose money and the military approaches strategic and logistic insolvency. This is the situation today; it is the situation prompting development of an intransit control system by the military and proposals by the Intransit Control Subcommittee of the SAE Advisory Committee on Air Cargo.

640659 The Aluminum Automobile Engine . . . Let's Take Another Look. J. M. Smith, Aluminum Co. of America. The physical and mechanical properties of aluminum, and its adaptability to several casting processes, offer advantages for automotive applications. In producing major parts, such as cylinder blocks and heads, by permanent mold or die casting methods, product design changes may be necessary to meet the limitations of the process. Casting alloys must be compounded to minimize galvanic corrosion. Stress analysis shows that an aluminum engine can attain durability equal to the standards of the industry. As a result of the decrease in engine weight other vehicle components can be lightened to achieve im-

proved handling and performance.

640660 Airlines See Different Paths To All-Weather Landings. R. C. Collins, United Air Lines, Inc.; F. Ormonroyd, British European Airways; L. C. Keene, L. O. Gilmore, B. C. Hawkins, and K. B. Olsen, American Airlines, Inc. All-weather landing bids fair to be a reality on major airlines well within the next decade. Many airline engineers see a fully automatic system as necessary to fulfill all the requirements. Others feel the scales tip in favor of an instrument system by which the pilot lands the airplane. British European Airways believes the ultimate all-weather landing system must increase the safety level in good weather as well as bad. This result, they feel, can be attained at this time, "only through use of a fully automatic system capable of surviving a single major failure." The program American Airlines is working on is based on the use of an autopilot in the automatic coupled approach mode, monitored by the captain and first officer. United Airlines engineers, on the other hand, see one fact (pilot acceptability) as tipping the scales away from an autopilot solution in favor of what they call a "real world" instrument system.

640661 Microwelds Develop Muscles. F. R. Sullivan, Aerojet-General Corp. Microwelding is being used to connect devices covering the entire spectrum of microelectronics and others not necessarily electronic in nature. These include devices consisting of thin metal films on a variety of substrates, integrated circuit packages to be placed upon printed circuit boards, discrete devices to be interconnected, and miscellaneous related small components.

640803 1965 Passenger-Car Engineering Trends. Walter G. Patton, SAE Journal. Partly influenced by the development of special bodies and power trains for compacts and sports cars, there is a continuing

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trend toward giving the customer a bigger choice of body style, engine, transmission, suspension, and the like. The sports car, for example, has made popular the "two-plus-two" body, the console, and the 4-on-the-floor transmission. Many of the small cars are larger than they were when they were introduced, but they still fall within the "small car" classification. Along with these general trends, the following more specific engineering trends can be noted:

- Most cars are longer and wider.
- Some roof lines are lower, although the average car height remains about the same.
- Wider track cars are becoming more common.
- Adoption of the perimeter frame and curved side windows has made cars roomier.
- Horsepower is still going up and engine weight down.
- Corrosion is being minimized through the use of more galvanized steel, new electrolytic methods of applying primer, better design to keep water from collecting in underbody areas.
- Low-section tires, introduced a year ago, are being used on almost all cars.
- Disc brakes are standard on three cars, optional on several others.

640804 Small Company Engineering Has To Be Good - Or Else. C. L. Callum, J. I. Case Co.; and C. W. Bricher, Farmhand Division, Daffin Corp. Engineering in a short-line farm equipment company is under constant pressure to be highly efficient. Since its product line is so limited that dealers selling it have to handle other lines as well, engineering has to be set up with particular care. A few bad years can easily put such a small company out of business. Engineering departments in these companies (\$2 million

to \$20 million of gross sales per year) have to operate in a very business-like manner. Like larger companies, they have to accept the rule of thumb that adequate engineering requires one designer per million dollars of sales. So, best use has to be made of available personnel. . . . Systems must be properly designed and records properly maintained, because the engineering department must be prepared to grow with the company. Drawings must be accurate and complete, and all bills of material must be correct, if the industrial engineer, production engineer, purchasing department, quality control engineer, and accountant are to perform their jobs efficiently.

640805 Jet-Lift VTOL Principle Chosen For Two Very Different Aircraft Missions. H. Deplante, Generale Aeronautique Marcel Dassault; and F. Hoffert, Dornier-Werke, GmbH. One would not expect a transport aircraft to have many similarities to a fighter aircraft, or vice versa, yet the West German DO-31 military transport and the French Mirage V fighter are very alike in many respects. They both use the same powerplant combination. A large jet engine for forward flight is augmented by a number of smaller jet engines for vertical takeoff and landing. Their control systems for VTOL flight are also similar, although less so than their powerplants. They depend on reaction jets fed by air bled from their lift engines to make up for the fact that in the nearly motionless flight of VTOL, the conventional aerodynamic control surfaces are useless.

640806 Electrochemical Machining - Now A Practical Production Tool. W. B. Kleiner and F. A. Pitschke, Ionic Machine Co. Electrochemical machining removes metal

without heat distortion, work hardening, or disturbance of the metallurgical properties of the work piece. It is a high-speed reverse plating process. The work is the anode, the tool is the cathode. As the tool is advanced by precise mechanism toward the work, an electrical conducting solution is pumped between the work and the tool and the work is depleted at high current density ahead of the advancing tool.

640807 Scale Models Found Good Route To Soil Mechanics Data. R. J. Sullivan, Caterpillar Tractor Co. Scale-model testing is indicated for many earthmoving units. Consider, for example, a scraper that is normally loaded from the bottom, with soil flowing over the cutting edge and being forced upward to fill the bowl. From the time a given particle is separated from the earth by the cutting edge, it is subjected to a sequence of forces, under whose influence it eventually comes to rest at some final position in the bowl. Why does the particle end up at that particular position? No mathematical theory or analysis can yet give the answer. Also, why it's harder to load some soils than others is imperfectly understood. So is the mechanisms by which various properties of a soil influences its behavior.

640808 No Problem Too Small For Computers. W. R. Moreland, Aircraft Division, Douglas Aircraft Co., Inc. The Aircraft Division of Douglas recently undertook a study to determine the causes behind a general reluctance on the part of engineering personnel to utilize electronic computer facilities for solution of their day-to-day technical problems. Four major obstacles to more complete utilization of computer facilities were uncovered by the study: poor communications; insufficient knowledge of computer capabilities; lack of a rapid means for solving small problems; inadequate assistance provided by computer services department.

640809 Only A Whisper From New Portable Powerplant. D. R. Snoke and G. L. Mrava, Electromechanical Division, Thompson Ramo Wooldridge, Inc. A mercury Rankine-cycle power system is being developed to provide the Army with a silent, lightweight, versatile, self-sufficient, compact, hydrocarbon fueled powerplant for field use. This power generator converts heat from burning hydrocarbon fuel into useful electrical power through a hermetically sealed mercury Rankine cycle. The system consists of a mercury preheater and radiant and convection heated boiler, a turbo-alternator pump unit, an air-cooled mercury condenser and sub-cooler, and the necessary system controls.

640810 Long-Life Space Designs Are Out of This World. Life and reliability requirements are being achieved with space gears, long-life lubrication for space servomechanisms, mercury-lubricated bearings, gas bearings for turbomachinery, and metallic flexures. There have been these successes despite the fact that spacecraft equipment design is more stringent than its earthly counterpart. . . . Besides maximum reliability and long life, space equipment requires minimum weight and size, and unattended operation in a hazardous environment. Although there are still problems, these have been defined and can yield to further technological advances.

640811 Wing Structure Suits Supersonic Transport. J. D. Van Dyke, Jr., Douglas Aircraft Co., Inc. Can a Mach 3 supersonic transport be built with the materials, fabrication methods, and cost realities of today? Finding the answer to this question occupies a sizable part of this country's aerospace efforts. Among the indications of future success are the early reports from wing structure designers. Tests show that several structural configurations have satisfactory static and fatigue

strengths, and fabrication problems are less severe than originally anticipated.

640812 Equipment Needs Changing For Interstate Highway Mowing. J. E. Bell, Illinois Division of Highways, Bureau of Maintenance. To mow Interstate Highway rights-of-way, either more tractor-mower units than commonly used are needed, or tractor-mower combinations with increased mowing capacity. Based on present experience, two larger-capacity units and one smaller tractor-mower unit are needed for every 12 centerline-miles of Interstate Highway right-of-way.

640813 Reliability Program Can Make A Good Diesel Even Better. W. J. Lux, Defense Products Division, Caterpillar Tractor Co. The principles of reliability, so widely used especially in the missile and electronics equipment fields, can also help to improve such a heavy-duty and durable product as the diesel engine. In fact, Caterpillar, with a reliability program already in operation in its Defense Products Division, is also using the extensive laboratory and endurance test results and field data available on hundreds of engines to study the failure rate characteristics of diesel engines. The results of these studies should prove useful in developing a reliability program tailored to the needs of the diesel engine.

640814 Commercial Vehicle Design Trends in the United Kingdom. M. Platt, Engineering Consultant. The long-term effect of the new regulations for trucks operating in the United Kingdom will undoubtedly be to accentuate the trend towards greater gross vehicle weights for the medium-priced medium-sized trucks in volume production, which have for some years progressively encroached upon the sector of the market traditionally held by the "heavies." Thus, expressed in terms

of approximate payload, the volume class of the 2-axle truck has gradually shifted from the prewar 3-tonner to the 5-tonner, and then toward the 8-tonner, during the past 20 years, with a top limit of about 25,000 lb gvw.

640815 Corrosion Control Extends From The Production Line To The Road. Prevention of corrosion is an important design consideration for many applications of metals. In some cases, corrosion resistance may be the dominating factor governing the selection of material or process; in others, it will be secondary to economic considerations, physical properties, or the many other factors which are evaluated in such a selection. Preventing or retarding corrosion on specific parts may be important from the standpoint of assuring proper engineering function, contributing to service life, or producing and maintaining appearance. The designer should be familiar with the part that corrosion prevention plays in the selection of metal and/or treatment, so that the performance complies with the requirements. With the use of salt for de-icing and dust control increasing at a rapid rate for the past several years, the corrosion problem has become recognized as one of primary importance. In addition, the adoption of extended warranty periods has made it mandatory that immediate steps be taken to reduce this corrosion problem.

640816 DC-9 Designed For Economy. R. E. Bates, Aircraft Division, Douglas Aircraft Co., Inc. Cost savings have been designed into the DC-9, a highly-efficient, 2-engine, short-to-medium range jet aircraft. Its operating cost is low in terms of dollars per mile; its size and speed offer low cents-per-seat-mile costs and high traffic-carrying potential. These cost advantages are magnified by various design features.

640817 Electron-Beam Welding Speeds Production Process. J.

ABSTRACTS OF TECHNICAL ARTICLES

W. Meier, Hamilton Standard Division, United Aircraft Corp. There are two electron-beam welding techniques—vacuum and nonvacuum. Both produce deep narrow fusion zones which minimize heat input requirements and so minimize distortion and effects on material properties. Both permit very rapid single-pass welding with precise control. Each has its advantages and disadvantages.

640818 Proper Probes Keep Thermocouples Reading True. P. T. Vickers, General Motors Research Laboratories. It is theoretically possible to measure the temperature of a fluid with a bare wire thermocouple and then correct the indicated reading to account for these environmental effects. This is seldom advisable because these effects may not be small enough to be considered as independent phenomena, and the correction equations would become very cumbersome. Usually, it is better to counteract the error-causing effects by using a well-designed probe. The probe's function is to synthesize an appropriate environment for the junction so that the temperature of the junction will be sufficiently close to the temperature of the fluid. Since a properly designed probe will minimize the environmental effects, each effect will be small enough so that it will not influence the others. The errors caused by each effect can, therefore, be separately evaluated.

640819 To Improve Car Handling . . . Look At The Chassis. D. L. Nordeen, General Motors Corp. Several aspects of vehicle directional control must be considered in determining the effect of chassis parameter changes on the vehicle control re-

sponse. These include: steady-state characteristics, nonlinear tire forces, the mathematical model and the axis system used for analysis, linear transient response, path response, nonlinear response, and forward speed. The parameter study shows the effects of small changes in chassis parameters on the response of the vehicle, and enables the designer to assess the handling qualities of the vehicle during the design phase.

640820 Steam Puts Gleam on Portable Powerplants For Remote Area Operations. R. J. Harvey and T. C. Robinson, Thermo Electron Engineering Corp. Reciprocating steam engines appear particularly attractive for portable power applications in remote areas of the world. Closed-cycle operation provides:

- Multifuel capability.
- High reliability with simple, routine operation and maintenance.
- Positive starting capability.
- Cost, efficiency, and weight comparable to internal-combustion engines.

640821 Variable-Sweep SST Takes Off And Lands Slower, Shorter, and Quieter Than Subsonic Jets. J. M. Swihart and L. T. Goodmanson, Supersonic Transport Airplane Division, Boeing Co. Variable-sweep wings on the Boeing-designed supersonic transport provide aerodynamic and operational benefits. These include shorter take-offs and landings, lower take-off and approach noise, and lower take-off and landing speeds than present subsonic jets. In addition, this configuration has a smaller gross weight and smaller engines than a low aspect ratio, fixed-geometry SST would have for a given mission. The craft has

the same construction that Boeing has used on all its jet transports and bombers. The only new feature is a straight-forward wing pivot which has dual-load-path fail-safe design.

640822 Fatigue Design of Springs Doesn't Have to be Difficult. G. W. Kurasz and W. R. Johnson, Associated Spring Corp. The fatigue design of springs is related to the fundamentals of metal strength, stress, and environment. Although the understanding and interpretation of these basic concepts can be complicated, all the basic design information can be reduced to a few simple rules that apply generally to all spring configurations.

640823 Rubber Tires Playing Major Role in Monorail Systems Design. D. R. Miller, Daniel, Mann, Johnson, & Mendenhall. Rubber tires are already being used on important "monorail" systems; seem destined for wide application on future systems. (The term "monorail" is often used to apply to systems of guided vehicles for rapid transit service, most of which really are duorails, trirails, or even hexarails—rather than monorails). Three types of monorails using rubber tires are already operating.

640824 Which Smokemeter Is Best? It Depends On The Smoke. To obtain useful information on diesel smoke measurement, the CRC Smokemeter Group, in co-operation with the U.S. Army, conducted a series of tests at Aberdeen Proving Ground, Md., in May 1962. The objective of this work was to establish a technically sound and exactly defined method of measuring the "density" of smoke from diesel engines in laboratory tests. During the program 27 smokemeters, 5 laboratory engines, and 4 military vehicles were used. Some of the recommendations of this group, regarding smokemeter selection, sampling techniques, expression of data, and visual ratings are outlined here.

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